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The effect of smoking on the health status of the supporting tissues around dental implant; a systematic review

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Abstract

Background:

Smoking is a well-established risk factor for dental implant failure and peri-implant tissue complications. This systematic review synthesizes evidence on the effects of smoking on the health of supporting tissues around dental implants, including marginal bone loss, soft tissue inflammation, and peri-implant disease.

Methods:

A comprehensive literature search was conducted following PRISMA guidelines across PubMed/MEDLINE, Science Direct, Web of Science, and Cochrane Library (inception to May 2025). Eligible studies included human subjects aged ≥18 years, assessing smoking's impact on peri-implant health (e.g., probing depth, bleeding on probing, marginal bone loss). Risk of bias was evaluated using the Newcastle-Ottawa Scale for observational studies.

Results:

A total of eight studies were included that include six retrospective cohort and two cross-sectional studies, totaling 1,228 implants. Smokers demonstrated significantly greater marginal bone loss compared to non-smokers, with a clear dose-response relationship observed between smoking frequency and bone loss severity. Soft tissue parameters including plaque index, probing depth, and gingival index were all significantly worse in smokers, with one study reporting 40.3% of smokers showing severe plaque accumulation versus 16.9% in non-smokers. The prevalence of peri-implant inflammation was markedly higher among smokers, reaching 63.2% compared to 39.1% in non-smokers.

Conclusions:

The evidence consistently indicates that smoking adversely affects peri-implant tissue health, increasing risks of bone loss, inflammation, and peri-implant disease. These findings underscore the importance of preoperative smoking cessation counseling and long-term monitoring for smokers with dental implants to optimize treatment outcomes.

Introduction

The interplay between smoking and oral health has been a subject of considerable research, particularly concerning its deleterious effects on dental implants and the surrounding supporting tissues. Smoking is widely acknowledged as a significant risk factor for implant failure, with studies consistently reporting that smokers experience higher rates of complications compared to non-smokers. For instance, Wu et al. highlighted a marked increase in the risk of dental implant failure associated with smoking habits, attributing this to impaired bone healing post-surgery [1]. These findings are supported by additional cohorts identifying that the odds of failure can be significantly amplified for smokers, reflecting the detrimental impact of smoking on the wound-healing processes critical to osseointegration—the biological process wherein the implant fuses to the bone [2].

The systemic implications of smoking extend beyond immediate complications, influencing the long-term stability of dental implants. A systematic review conducted by Al-Bashaireh and colleagues synthesized evidence from numerous studies and underscored the association between smoking and a range of complications including peri-implantitis, mucositis, and implant loss [3]. Moreover, cumulative cigarette exposure has been shown to exacerbate these risks, indicating a dose-response relationship where longer smoking histories correlate with higher incidents of bone loss surrounding implants [4]. This observation is concerning, especially given that the quality of the bone—the primary support structure for dental implants—is compromised in smokers due to associated reduced blood flow and impaired healing capabilities [5].

Furthermore, the biological mechanisms underpinning these adverse effects can be traced to the influence of nicotine and other harmful substances found in cigarettes. For instance, nicotine has been implicated in the upregulation of pro-inflammatory cytokines such as interleukin-1β and tumor necrosis factor-α, which not only promote inflammation but also contribute to alveolar bone loss around natural teeth and implants [6,7]. Therefore, smoking not only elevates the risk of initial implant failure but also aggravates the condition of peri-implant tissues, making it imperative for healthcare providers to consider these factors when planning dental procedures.

Thus, the adverse effects of smoking on the health status of supporting tissues around dental implants are multifaceted and significant. With evidence linking smoking to increased failure rates, peri-implantitis, and impaired osseointegration, it becomes vital for clinicians to address smoking habits with patients preoperatively. Smoking cessation strategies should be encouraged to improve patient outcomes, thereby enhancing the longevity and success of dental implants in individuals who smoke. This systematic review aims to evaluate the effects of smoking on the health of supporting tissues around dental implants, including marginal bone loss, soft tissue inflammation, and peri-implant disease.

Methods

Study Design

This systematic review was conducted to evaluate the effect of smoking on the health status of the supporting tissues surrounding dental implants. The review was performed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [8].

Eligibility Criteria

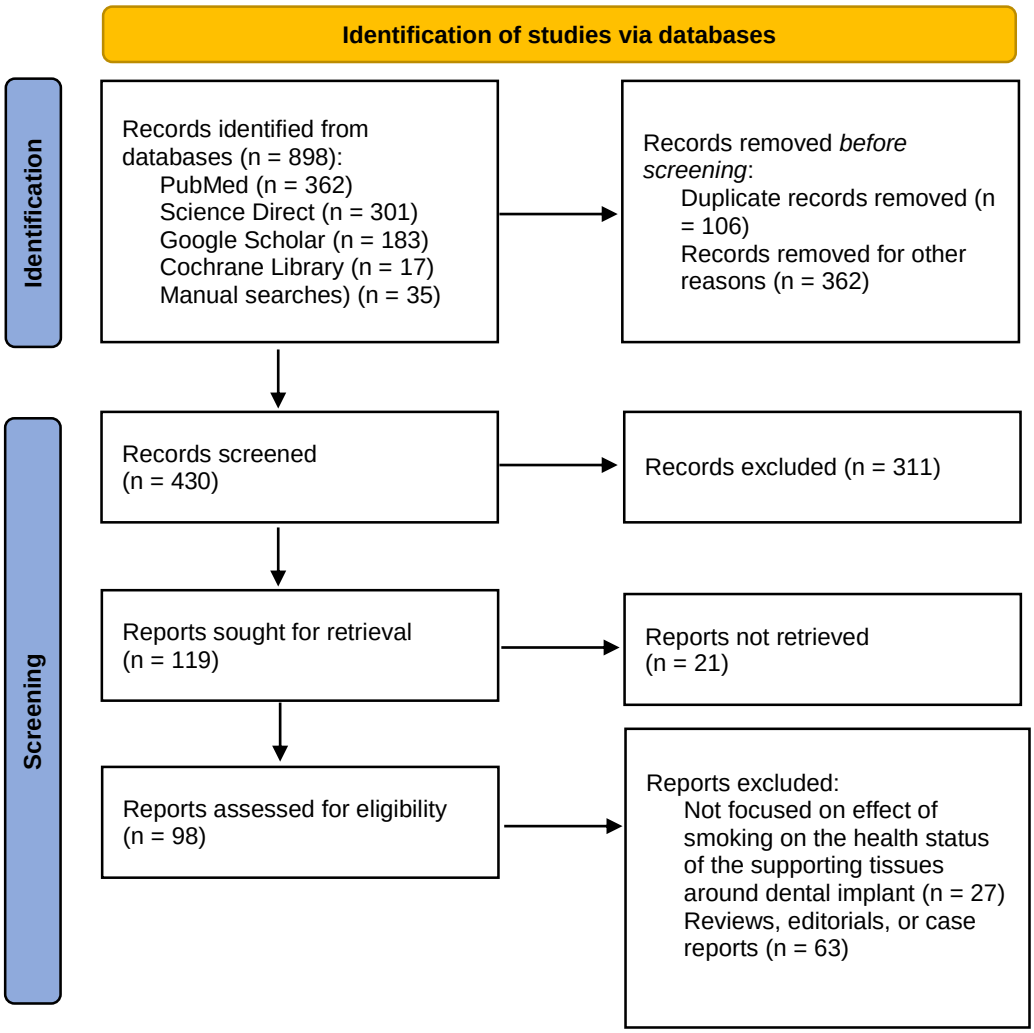
Studies were considered eligible if they involved human subjects aged 18 years or older and assessed the impact of smoking on peri-implant tissue health. This included parameters such as probing depth, bleeding on probing, marginal bone loss, and the presence of peri-implantitis. Both observational studies—including cohort, case-control, and cross-sectional designs—and interventional studies were included, provided they were published in English and appeared as full-text articles in peer-reviewed journals. Studies were excluded if they involved animals or in vitro models, were case reports, editorials, letters to the editor, or narrative reviews, or if they lacked sufficient data regarding smoking status or peri-implant outcomes.

Information Sources and Search Strategy

A comprehensive literature search was conducted using the following electronic databases: PubMed/MEDLINE, Science Direct, Web of Science, and Cochrane Library. The search included articles published from database inception up to May 2025. Keywords and Medical Subject Headings (MeSH) used in various combinations included "smoking," "tobacco use," "dental implants," "peri-implantitis," "peri-implant tissue," "marginal bone loss," and "implant health." Manual searches of reference lists of included articles and relevant reviews were also conducted to identify additional eligible studies.

Study Selection Process

All identified records were imported into a reference management tool (Zotero) and duplicates were removed. Titles and abstracts were independently screened by two reviewers to assess eligibility. Full-text articles of potentially relevant studies were then retrieved and assessed for inclusion. Any disagreements between reviewers were resolved through discussion or consultation with a third reviewer.



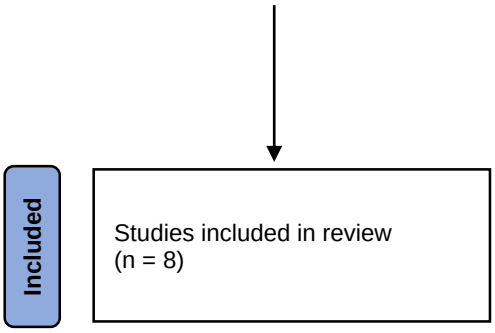


Figure 1: PRISMA flowchart showing the study selection process.

Data Extraction

Data extraction was conducted using a predesigned, standardized form. Information extracted included author names, year of publication, country of origin, study design, sample size, participant demographics, classification of smoking status (e.g., current or former smoker, pack-years), implant characteristics (such as location, type, and time in function), and the peri-implant health outcomes measured.

Quality Assessment

The quality of included observational studies was assessed using the Newcastle-Ottawa Scale (NOS). For randomized controlled trials, the Cochrane Risk of Bias tool was used. Two reviewers independently conducted the assessments, and discrepancies were resolved by consensus.

Results

This systematic review included eight studies (Table 1), comprising six retrospective cohort studies [4,5,7,9,10] and two cross-sectional studies [6,11] and one observational study [12]. Collectively, these studies evaluated 1,228 dental implants across smokers and non-smokers, with follow-up periods ranging from 6 months to 5 years.

Table 1: Summary of included studies

Author (Year)	Study Design	Sample Size (Smokers/Non-Smokers)	Follow-Up Period	Key Peri-Implant Parameters Assessed	Key Findings	Risk of Bias/Quality Assessment
Al Amri et al. (2016) [5]	Retrospective cohort	IL: 16 smokers, 15 non-smokers; DL: 17 smokers, 13 non-smokers	5 years	PI, BOP, PD ≥4mm, CBL (mesial/distal)	Higher PI, PD, and CBL in smokers ($p<0.05$). No difference between IL/DL loading protocols.	Moderate (Newcastle-Ottawa Scale)
Ali et al.	Retrospective	104 smokers (340 implants),	≥36 months	MBL, PI, PD, SBI	MBL increased with	Low (STROBE guidelines)

(2023) [4]	matched-control	100 non-smokers (337 implants)			smoking frequency ($p<0.05$). No difference in MBL between jaw locations.	
Mumcu & Bekleen (2019) [9]	Retrospective cohort	ISFP: 31 smokers, 106 non-smokers; ISRP: 21 smokers, 73 non-smokers	24 months	PI, GI, PD, MBL (mesial/distal)	Greater MBL in smokers with ISRP vs. ISFP ($p<0.05$). Higher PI/PD in smokers.	Moderate (Self-reported smoking)
Mumcu & Dayan (2019) [10]	Retrospective cohort	52 smokers, 179 non-smokers (315 implants)	36 months	PI, SBI, PD, MBL (maxilla/mandible)	Higher MBL, PI, and PD in smokers ($p<0.001$). No location-based differences.	Moderate (Single-center bias)
Rismanchian et al. (2020) [11]	Cross-sectional	30 smokers / 30 non-smokers	6+ months	Probing depth (PD), gingival index (GI), bleeding on probing (BOP), plaque index (PI), bone loss	Smokers had higher GI (2.17 vs. 1.77, $P<0.001$), severe plaque (40.3% vs. 16.9%, $P=0.008$), and greater bone loss (1.57 mm vs. 1.39 mm, $P=0.015$). PD was similar ($P=0.31$).	Moderate (convenience sampling)
Sahin (2023) [12]	Observational	149 implants smokers / 149 non-smokers	6 months–5 years	Keratinized gingiva width, vestibule depth, pink esthetic score	Smokers had higher IDRA scores	Low (controlled for

				(PES), implant disease risk (IDRA)	(P<0.05), narrower keratinized gingiva (P<0.05), and lower implant health scale success rates (94.6% vs. 100%). PES was similar (P>0.05).	confounders)
AlHarthi et al. (2017) [7]	Retrospective	44 smokers / 43 non-smokers	Not specified	Plaque index (PI), bleeding on probing (BOP), probing depth (PD), crestal bone loss (CBL)	Smokers had higher PI (63.2% vs. 39.1%, P<0.05), PD (7.5 mm vs. 5.1 mm, P<0.05), and CBL (6.4 mm vs. 4.1 mm, P<0.05). BOP was lower in smokers (16.4% vs. 41.5%, P<0.01).	Moderate (retrospective design)
Akram et al. (2017) [6]	Cross-sectional	44 smokers / 45 non-smokers	Not specified	Plaque index (PI), bleeding on probing (BOP), probing depth (PD), crestal bone loss (CBL), IL-1β, MMP-9	Smokers had higher PI (64.2% vs. 32.6%, P<0.05), PD (5.9 mm vs. 4.8 mm, P<0.05), CBL (4.3 mm vs. 2.3 mm, P<0.05), and proinflammatory	Moderate (single-center study)

					cytokines (IL-1β: 282.1 vs. 145 pg/mL, P<0.01). BOP was lower (22.8% vs. 39.9%, P<0.01).	

The study by Al Amri et al. [5] found that smokers exhibited statistically significant increases in plaque index (PI) and probing depth (PD) (P<0.05) compared to non-smokers, while non-smokers had higher bleeding on probing (BOP). Additionally, CBL was significantly worse in smokers across both immediately-loaded (IL) and delayed-loaded (DL) groups (P<0.05). The study concluded that tobacco smoking exacerbates peri-implant soft tissue inflammation and crestal bone loss (CBL), with no significant difference in peri-implant hard and soft tissue conditions between IL and DL protocols, suggesting that smoking negatively impacts implant health regardless of loading type.

The study by Mumcu & Beklen [9] reported that smokers had significantly poorer clinical outcomes compared to non-smokers, with a notable trend of increasing marginal bone loss over time. Specifically, in the ISRP group, smokers exhibited greater marginal bone loss than those with ISFPs, reflecting the detrimental effects of smoking exacerbated by the type of prosthesis. The study concluded that smoking negatively affects implant outcomes, particularly around removable prostheses. It emphasized the importance of stringent oral hygiene practices and regular dental follow-ups for smokers to mitigate bone loss surrounding implants. Understanding the interplay between smoking and prosthesis design can inform tailored treatment approaches in dental implantology. The study by Mumcu & Dayan [10] employed a retrospective design, evaluating records from 120 patients (68 women and 52 men, aged 19–74 years) with a total of 315 dental implants placed between 2012 and 2019. Patients were categorized as smokers or non-smokers based on their tobacco use history, and various peri-implant parameters were measured, including marginal bone loss (MBL), PI, sulcus bleeding index (SBI), and PD, over a 36-month period following implant loading. The findings revealed that smokers exhibited significantly greater MBL, PI, and PD scores compared to non-smokers, with a correlation between PI and PD scores present in both groups. Notably, there was no significant difference in SBI between smokers and non-smokers. The study concluded that smoking is associated with increased marginal bone loss around dental implants, regardless of implant location in the jaws, and both plaque indices and probing depths were higher in smokers.

The study by Rismanchian et al. [11] employed a cross-sectional design to compare the health of soft and hard tissues surrounding dental implants in smokers and non-smokers. A total of 30 smokers and 30 non-smokers who had received dental implants were selected, and various health indicators were measured, including the probing depth (PD), bleeding on probing (BOP), gingival index (GI), and PI, along with MBL assessed through radiography. The findings revealed that smokers had a mean gingival health index of 2.17 ± 0.63, significantly worse than the non-smokers at 1.77 ± 0.87, indicating poorer soft tissue health. Furthermore, 40.3% of smokers exhibited severe plaque around their dental implants compared to 16.9% of non-smokers, and bone loss was also greater in the smoker group (1.57 ± 0.44 mm vs. 1.39 ± 0.44

mm in non-smokers). The study concluded that the health of soft and hard tissues around dental implants is significantly compromised in smokers.

The study by Sahin et al. [12] involved 298 dental implants placed in systemically healthy patients aged between 38 and 62 years, who had functional prosthesis-loaded implants for a minimum of six months and a maximum of five years. The implants were categorized based on smoking status into smokers and non-smokers. The results indicated a statistically significant difference in the implant disease risk assessment scores between smokers and non-smokers ($p < 0.05$), with non-smokers exhibiting greater implant success rates and wider keratinized gingiva. The study concluded that smoking adversely affects the long-term survival of dental implants and the health of surrounding tissues.

The study by AlHarthi et al. [7] involved a retrospective analysis of 128 male participants divided into three groups: 44 cigarette smokers (CS), 41 waterpipe smokers (WS), and 43 never-smokers (NS). Demographic data were collected via a questionnaire, and specific clinical parameters related to peri-implant health were assessed, including peri-implant PI, BOP, PD, and CBL measured through standardized digital radiographs. The findings indicated that both CS and WS had significantly higher peri-implant PI and PD compared to NS, with elevated BOP levels in NS when contrasted with the two smoking groups. Additionally, both smoking groups exhibited greater CBL than NS, with no statistically significant differences observed between CS and WS concerning any of the evaluated parameters. In conclusion, the results affirm that cigarette and waterpipe smoking substantially deteriorate peri-implant soft tissue inflammatory parameters and contribute to increased crestal bone loss compared to never-smokers, challenging the perception that waterpipe smoking is less harmful to periodontal health than cigarette smoking.

The study by Ali et al. [4] utilized a retrospective matched-control design to compare MBL around dental implants in smokers and non-smokers, categorizing smokers into five groups based on daily smoking frequency (non-smokers, 1–5, 6–10, 11–15, and 20 cigarettes/day). A total of 340 implants in 104 smokers and 337 implants in 100 non-smokers were included, all with a minimum of 36 months of radiological follow-up. The findings revealed a positive correlation between the degree of smoking and MBL, indicating that heavier smoking was associated with greater bone loss. Notably, smokers who consumed 11–20 cigarettes per day showed a similar MBL to non-smokers. Other variables such as bruxism and the type of prosthesis fixation also significantly influenced MBL. The study concluded that smoking frequency has a detrimental effect on bone health around dental implants, reinforcing the need for careful consideration of smoking habits in dental implant outcomes.

The study by Akram et al. [6] employed a cross-sectional design that involved 131 participants divided into three groups: cigarette smokers (CS), smokeless tobacco users (STU), and non-tobacco users (NTU). Each participant completed a structured baseline questionnaire to collect demographic data and tobacco usage details. The findings demonstrated that both CS and STU exhibited significantly higher peri-implant PI, BOP, PD, and CBL compared to NTU, indicating poorer peri-implant health among tobacco users. Additionally, the levels of IL-1b and MMP-9 in PISF were significantly elevated in both CS and STU compared to NTU, reinforcing the adverse effects of tobacco use on inflammatory responses around dental implants. The study concluded that clinical and radiographic peri-implant parameters were compromised among CS and STU compared to NTU. This suggests that increased expression of local pro-inflammatory cytokines may explain the greater susceptibility of tobacco users to peri-implant breakdown.

Discussion

The detrimental effects of smoking on oral health, particularly concerning dental implants and their supporting tissues, are well-documented in the literature. Smoking not only compromises the systemic health of individuals but also exerts profound localized effects that impact the outcomes of dental implant treatments. Numerous studies have converged on the conclusion that smokers face heightened risks of peri-implant diseases, including peri-implantitis, compared to non-smokers. For instance, a systematic review by Chrcanovic et al. indicated that smoking significantly increases the likelihood of both implant failure and marginal bone loss, highlighting the association between smoking and postoperative complications around dental implants [13]. This is particularly pertinent given that the biological mechanisms, such as impaired osseointegration and altered inflammatory responses, are at play.

Smoking has been shown to influence the composition of the peri-implant microbiome, creating a pathogenic environment conducive to disease. Research conducted by Zhang et al. elucidated how smoking alters the microbial community structure around implants, resulting in a more resilient microbiome that is less responsive to treatment interventions (Zhang et al., 2022). Additionally, Ata-Ali et al. reported that smoking is associated with increased levels of pro-inflammatory cytokines such as interleukin-6 and tumor necrosis factor-alpha, which can exacerbate tissue destruction and bone loss in peri-implant areas [14]. The resultant oxidative stress and reduced oxygen tension due to smoking create a hostile environment for healing and maintenance of peri-implant tissues, further complicating patient outcomes [15].

It is also essential to consider the impact of cumulative smoking exposure, which significantly correlates with the severity of peri-implantitis. Ferreira et al. revealed that higher levels of smoking were associated with increased prevalence of peri-implant mucositis and related complications [16]. Furthermore, the findings of Moore et al. reinforced this by showing a direct relationship between smoking habits and the incidence of implant failure in patients, indicating the broader significance of smoking cessation as a necessary preoperative intervention to enhance long-term implant success [17].

This systematic review consolidates robust evidence demonstrating that smoking significantly compromises peri-implant tissue health, leading to increased marginal bone loss, inflammation, and peri-implant disease. The dose-response relationship between smoking frequency and adverse outcomes underscores the need for tailored patient education and intervention strategies. Clinicians must prioritize smoking cessation counseling and rigorous long-term monitoring to mitigate these risks. Future research should explore targeted therapeutic approaches to counteract smoking-related peri-implant complications and further elucidate the underlying biological mechanisms. By addressing smoking as a modifiable risk factor, dental professionals can enhance implant success rates and improve patient outcomes. These findings reinforce the imperative for interdisciplinary collaboration to integrate smoking cessation programs into routine dental care, ultimately promoting better oral and systemic health.

Conclusion

The findings of this systematic review underscore the significant adverse effects of smoking on the health of peri-implant tissues, including increased marginal bone loss, higher prevalence of peri-implant inflammation, and poorer soft tissue health compared to non-smokers. The evidence from the included studies consistently demonstrates a dose-response relationship, where greater smoking frequency correlates with more severe peri-implant complications. Smoking compromises osseointegration, exacerbates inflammatory responses, and alters the

peri-implant microbiome, all of which contribute to higher risks of implant failure and peri-implant diseases. These results highlight the critical need for preoperative smoking cessation counseling and long-term monitoring for smokers with dental implants. Clinicians should educate patients about the risks associated with smoking and encourage cessation to improve implant outcomes. Future research should explore targeted interventions to mitigate smoking-related peri-implant complications and further investigate the biological mechanisms underlying these effects. By addressing smoking as a modifiable risk factor, dental professionals can enhance the longevity and success of dental implants in affected individuals.

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